PH, pKa, Acids, Bases and Buffers.

Answers:

A. Answers could be found in the notes or in the textbook

B1. The [H+] in solution of strong acid or strong base is directly proportional to amount of acid or base added. If the concentration is low, as it is in the physiological range, addition of small amounts of acid or base makes a large relative change.

In contrast, the pH of a buffer is determined by the ration of conjugate acid to conjugate base. Both species are usually present in relatively high concentration. Under these conditions, adding small amounts of acids or bases makes a relatively small change in the ration of conjugate acid to conjugate base, and therefore makes a relatively small change in pH.

B2. The pKa(2) for phosphate is 6.7, which is within one log unit of the desired pH. Phosphate should therefore provide adequate buffering. The predominant species are the monobasic and dibasic forms.

C1. pH = -log $[H^+]$. Therefor the pH values are as follows

a) 6.0
b) 5.7
c) 5.4
d) 5.22
e) 5.1
f) 5.0

C2. $[H^+]$ = antilog (-pH). Therefore the $[H^+]$ at

pH 7.37 = 4.26×10^{-8} and

pH 7.43 = 3.71×10^{-8}

C3. $K_w = [H^+]\,[OH^-] = 1.0\ 10^{-14}\ M^2$

C4. The answer is not pH = 8. This answer could be correct if pure water contained zero H^+. But pure water contains 10^{-7}M hydrogen ions. Therefore, the pH would be slightly less that 7. As a rough approximation we could simply add the contribution of protons from water and from the HCl:

10^{-7} + 10-8 = 1.1 x 10^{-7};
pH =6.95

C5. For convenience, we define the endpoint as two log units on either side of the pKa. Since the pKa for ammonia (to be precise, the ammonium ion) is 9.4, the acid end point is 7.4.

C6. Use Handerson-Hasselbalch equation.

([Acetate] / [Acetic acid]) = antilog (pH-pKa)

The pKa for acetic acid is 4.74. Therefore the [Acetate] / [Acetic acid] ratio increases as follows

For pH 3 $\rightarrow$ 0.018
pH 4 $\rightarrow$ 0.18
pH 5 $\rightarrow$ 1.8
pH 6 $\rightarrow$ 18

C7. There are 4 mmols HCl at the stare. Adding 5 mmols KOH produces a solution with an excess of 1 mmol of KOH. If the volume is still approximately 1 liter, the $[OH^-]$ = 1 x 10-3 M

The $[H^+] = 10^{-14}/ 10^{-3}$ = 10-11, corresponding to pH 11.